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(54) A method for producing polymer fibers and apparatus therefor

(57) The object of the present invention is a method for producing hydrophobic polymer fiber filaments, the method comprising the following steps

- forming a melt from a hydrophobic polymer,
- melt-spinning the polymer to form filaments,
- applying a spin finish to the filaments, and
- optionally crimping and cutting the filaments into staple fibers. According to the invention, the method includes a step of subjecting the filament to at least one surface treatment step, preferably using a corona discharge or plasma treatment to increase the surface free energy thereof. An object of the invention is also an apparatus or production line for carrying out the method.

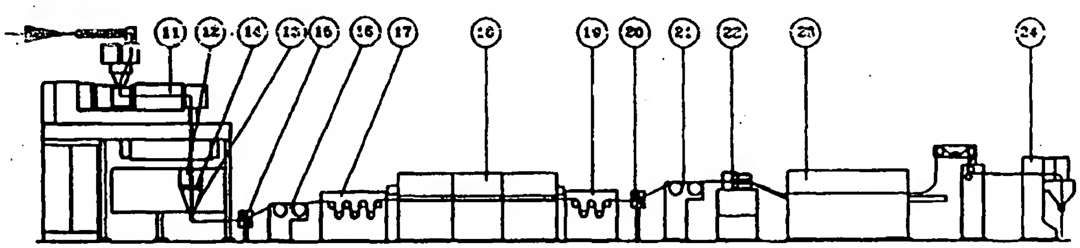

FIG. 1.

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Description

Background of the invention

[0001] Hydroentanglement or spunlacing is a nonwoven production method, where a fiber web is bonded by means of fine water jets under high pressure. In the most commonly applied process, a carded web is placed on a moving conveyor belt which transports the web under several rows of water jets. The water pressure in the jets is increased stepwise from the first array to the last array of jets. The fibers in the web are entangled by mechanical energy imparted to the web by the water jets. The entanglement retains the fibers in the nonwoven without the need for additional bonding such as thermal bonding or chemical bonding. Further general information about hydroentanglement can be found, for example, in the US patents nr. 3,485,706 and nr. 3,485,708 (Evans).

[0002] Various types of fiber compositions can be used to produce hydroentangled nonwovens. Typical fibers used are cellulose-based fibers such as cotton, pulp or viscose, and chemical fibers such as polyester (polyethylene terephtalate) or polypropylene. A typically used fiber mixture ratio is 30-70% viscose fibers and 70%-30% polyester fibers by weight of the web.

[0003] However, the use of polypropylene fibers in hydroentanglement is limited due to their hydrophobic nature. A water droplet forms a contact angle of about 105° on a polypropylene surface while it forms a contact angle of about 80° on a polyester surface. By definition, a surface is hydrophobic if the water contact angle is greater than 90° and hydrophilic if the said contact angle is smaller than 90°. Due to this difference in fiber wettability properties, hydroentanglement of a web containing polypropylene fibers is more diffucult than hydroentanglement of a web containing polyester fibers for two reasons. First, when the amount of hydrophobic polypropylene fibers is increased in the web, the water repellency of the web increases. Due to the increasing water repellency, the water jets do not penetrate the web completely. This effect leads to a loss of hydroentanglement energy absorbed by the web.

[0004] Second, the amount of spin finishes needed to control the fiber surface properties is different for polypropylene and polyester fibers. Typically, an amount of 0.5% of spin finishes, by weight of the fibers, has to be added to a polypropylene fiber surface in a staple fiber spinning process. For a polyester fiber surface, an add-on level of 0.10-0.15% of spin finishes, by weight of the fibers, is sufficient. The spin finishes to be applied are preferably conventional fiber finishes which are well known within the fiber industry. Generally, a spin finish is a mixture of surface-active agents containing cohesion agents, lubricants, antistatic agents, wetting agents and emulsifiers. The function of lubricants and cohesion agents is to reduce fiber-to-metal friction and to improve fiber-to-fiber cohesion by increasing fiber-to-fiber friction. The lubricants for fiber-to-metal surfaces are typically fatty acid esters, while the cohesion agents are ethoxylates of fatty acids. Antistatic agents reduce the build-up of static charge during fiber processing by providing a conductive layer on the fiber surface. The most commonly used antistatic agents in spin finishes are phosphate esters or quaternary amines. Wetting agents improve the wettability properties of fibers by reducing the water contact angle on the fiber surface. Emulsifiers are used to create oil-in-water spin finish emulsions which can be diluted with water. Suitable spin finish formulations are available *e.g.* under the trade names Silastol (Schill & Seilacher GmbH & Co., Boeblingen, Germany), Cirrasol (Uniqema, London, UK) and Stantex (Henkel KGaA, Duesseldorf, Germany).

[0005] The surface-active agents included in the spin finishes create problems in the hydroentanglement process. During hydroentanglement, spin finishes dissolve from the fibers into the hydroentanglement water. The dissolved spin finishes reduce the surface tension of the entanglement water and stabilize air bubbles in the water. Air stabilization causes water foaming, which is an undesired effect in hydroentanglement. Since the entanglement water has to be purified by filtration and circulated, the amount of impurities dissolved from the fibers in the water has to be kept as low as possible. The consumption of entanglement water during the hydroentaglement of a web containing polypropylene staple fibers is thus high. This is due to the fact that polypropylene fibers require typically about four times higher add-on levels of spin finishes than polyester or viscose fibers.

[0006] Today, various techniques exist for the modification of polymer surfaces. Techniques, such as plasma, corona or flame treatment, increase the surface free energy of low-energy polymer surfaces such as polyethylene or polypropylene. The increase of surface free energy can be observed as improved wetting properties and a decrease of the water contact angle. Plasma, corona and flame treatment are well known in the art of polymer engineering. These techniques have been applied for the modification of fibrous materials such as nonwovens in order to improve the wettability or adhesion properties of the materials. JP 01192871 A presents a method where a nonwoven fabric containing hydrophobic fibers is subjected to corona treatment to give the fabric hydrophilic properties. The patent application publication WO 97/11834 discloses a corona treatment method applicable amoung others for meltblown nonwovens to impart wettability properties to hydrophobic nonwovens. Tsai and Wadsworth, Textile Res. J., vol. 67 (1997), nr. 5., p. 359, report plasma treatment for increasing the surface free energy of polypropylene meltblown nonwovens.

Summary of the Invention

[0007] The present invention concerns a method for producing polymer, especially polyolefin fiber filaments with increased surface free energy, the method comprising the steps of forming a melt from a hydrophobic polymer, spinning the melt to form filaments, applying a spin finish to the filaments, and optionally crimping and cutting the filaments into staple fibers. According to the invention, a surface treatment step, preferably a corona discharge, plasma or flame treatment step is included in the method, for increasing the surface free energy of the fibers. The invention also concerns an apparatus or production line for carrying out the invention. The objects, features and advantages of the present invention will become fully apparent from the appended claims.

[0008] According to a preferred embodiment, the surface free energy is increased by corona or plasma treatment. This leads to two significant improvements to the current state of the art. First, the wettability properties of the filaments and fibers made therefrom improve and the absorption of entanglement energy during hydroentanglement of a web made from said fibers becomes more effective. Second, the add-on level of spin finishes, in order to impart good lubrication and antistatic properties to the fibers, can be reduced by 30-50% during spinning. As a result of the reduction of spin finish add-on level, less impurities dissolve from the web containing said fibers, into the circulating entanglement water.

Brief description of the drawings

[0009]

Figure 1 is a schematic representation of a short-spinning process for the production of polypropylene filaments and staple fibers according to the invention,

Figure 2 is a schematic representation of an embodiment of a corona treatment unit to be used according to the invention, and

Figure 3 is a schematic representation of a hydroentanglement production line.

Detailed description of the invention

[0010] According to a preferred embodiment, the present invention provides a method for producing polypropylene filaments and staple fibers therefrom for the manufacture of hydroentangled nonwovens. The method comprises corona-discharge, plasma or flame treatment of a polypropylene filament tow during a melt-spinning process. Although polypropylene is the preferred hydrophobic fiber in the manufacture of hydroentangled nonwovens, it should be observed that the method is also applicable for the production of fibers for hydroentanglement from other polymers having low surface free energy (water contact angle greater than 90°), such as polyethylene. Since the corona treatment is carried out in ambient air and it is a continuous process, corona treatment is the more preferred method for increasing the surface free energy of filaments during the melt-spinning process than the plasma or flame treatment techniques.

[0011] A typical corona discharge apparatus, well-known in the art, is comprised of two electrodes. A high AC voltage, having typically a frequency of 9-30 kHz and a voltage of 10-15 kV, is connected to a working electrode. The high voltage causes ionisation of the air in the gap between the two electrodes. This leads to an electrical discharge, known as a corona, between the working electrode and the second electrode which is electrically grounded. The grounded electrode is typically a roller made from stainless steel. Suitable materials for the working electrode are for example bare metals or ceramics. The isolator between the electrodes is the treated material and the air gap. When porous materials, such as filament tows, are treated, the material has to be electrically isolated from the electrodes. This is done by covering the roller electrode with a dielectric material, or more preferably, by using working electrodes which are covered with an insulating material such as a ceramic. However, when electrically insulated working electrodes are used, the corona-treatment efficiency decreases by about 50% compared to the case with bare metal electrodes.

[0012] The applicability of conventional corona treatment units having a roller-electrode configuration is limited to thin materials since the air gap between the electrodes can be adjusted typically between 1 mm and 2.5 mm. When thick materials or materials having 3-D structure are treated, plasma or corona jets are preferred. Corona jets blow ionised air generated by electrical discharge to the surface of the material to be treated.

[0013] During the electrical discharge, ions, radicals, excited molecules, photons and ozone are generated in the air gap between the electrodes. These components include energy enough to break the polymer chains on the surface of a treated polyolefin material, generating polymer radicals. Oxygen, including oxygen radicals, and ozone in the corona react with the polymer radicals on the material surface, forming peroxides. The peroxides react further on the polymer surface into oxygen-containing functional groups, such as -C-OH, -C=O, -COOH, -COOC- and -C-O-C. These

polar, oxygen-containing chemical groups increase the surface free energy of the polymer material and improve the wettability properties of the surface.

[0014] In Figure 1 is shown one preferred embodiment of a line for the production of polyolefin fibers with increased surface free energy. The titer of the fibers is preferably between 1.4 and 6 dtex. In the short-spinning line shown in Figure 1, polymer granulates are fed to an extruder (11) after which the melted polymer is pumped through a spinnerette (12) having a plurality of holes with a typical diameter of 0.25 mm. Polymer filaments forming a filament tow (13) are drawn from the spinnerette (12) with a first set of godets (17). After the spinnerette (12) the polymer filaments are quenched and a spin finish is added to the filament tow (13) with a kiss-roll applicator (14). The surface treatment unit (15) increases the surface free energy of the polymer filaments in the tow (13) by corona discharge or by plasma jet treatment. The treatment unit (15) is preferably capable of treating both sides of the tow (13). After the surface treatment (15), the polymer filaments in the surface portion of the tow (13) have an average water contact angle value of less than 95°, and more preferably a contact angle value of less than 90°. Since the surface treatment (15) imparts some electrical charge to the polymer filaments, the filament-to-filament cohesion in the tow (13) decreases. For this reason, an additional spin finish kiss-roll applicator (16) for the elimination of the electrical charge in the tow (13) is preferably provided after the surface treatment (15). Since the added spin finish in the filament tow (13) tends to decrease the efficiency of the surface treatment (15), the add-on level of spin finishes in the first kiss-roll applicator (14) is preferably less than 0.10 % by weight of the tow. The surface treatment (15) is preferably provided after the spinnerette (12), in the vicinity thereof, in which case the kiss-roll applicator (14) can be left out. According to a preferred embodiment, which is not shown in the drawing, a surface treatment step can be provided prior to the kiss-roll applicator (14), the embodiment comprising, in addition, a second surface treatment (20) and subsequent spin finish addition (21) step after the drawing oven (18). This position for the surface treatment close to the spinnerette is advantageous, as the filament tow (13) is here wide and thin. Also, in this position the filament tow (13) is unfinished and the loss of surface treatment efficiency, caused by spin finish, is avoided.

[0015] The filament tow (13) is drawn in a drawing oven (18) with a second set of godets (19). When the tow (13) is surface treated before the drawing oven (18), the draw ratio λ should preferably be less than 1.50 and most preferably less than 1.20, since drawing extends and enlarges the untreated surface area of the fiber tow (13). If the draw ratio λ exceeds 1.50, a second surface treatment unit (20) can be placed after the godets (19) in order to provide a re-treatment of the extended surface area.

[0016] Once the filament tow (13) is surface treated and drawn, it is re-finished with spin finishes in a kiss-roll applicator (21) and crimped in a crimper (22). The crimped filament tow is dried in a drying oven (23) and finally cut into staple fibers in a cutter (24). It should be observed that other fiber spinning techniques, such as long-spinning, can also be used for the production of polyolefin fibers according to the present invention.

[0017] Figure 2 shows schematically a typical corona-treatment unit for the treatment of the filament tow (13). The parts are as follows: (25) corona-discharge generator and high-voltage transformer, (26) discharge electrodes, (27) air gap and (28) grounded metal rolls.

[0018] Figure 3 shows schematically a typical production line for the manufacture of hydroentangled nonwovens, where the parts are as follows: (31) fiber feeder, (32) card, (33) 1st hydroentanglement station, (34) 2nd hydroentanglement station, (35) dryer and (36) nonwoven fabric winder.

[0019] The characteristic feature of the polyolefin staple fibers produced according to the present invention is the increase of surface free energy compared to fibers produced without the described surface treatment. Untreated polyolefin fibers, particularly polypropylene and polyethylene fibers, have a water contact angle value of about 95° - 105° or a critical surface tension of less than 33 mN/m. The surface treated fibers have an average water contact angle of less than 95°, or a critical surface tension higher than 33 mN/m, and more preferably a contact angle of less than 90°, or critical surface tension higher than 35 mN/m. The water contact angle values of individual fibers may vary from 60° to about 105°, or critical surface tension values from 49 mN/m to about 31 mN/m. This variation is due to the variation of the exposure of individual filaments in a tow to the surface treatment. It is clear that the filaments on both sides of the tow absorb most of the treatment energy, while the filaments in the middle of the tow get less treatment.

[0020] It has now been found that sufficient antistatic and hydrophilic properties can be brought to corona-treated polyolefin, preferably polypropylene filaments and fibers, by using 30-50% less spin finishes than in the current state of art. It is believed that when the surface free energy of polyolefin fibers is increased, the spin finishes spread more uniformely on the fiber surface. The critical surface tension of as-spun polypropylene filaments used in the production of polypropylene staple fibers for hydroentanglement has been determined to be ranging from 30.3 mN/m to 31.0 mN/m. On the other hand, the surface tension of neat spin finish oils are typically in the same range, while the surface tension of spin finish water dispersions used in the production of polypropylene staple fibers range from 30 mN/m to 40 mN/m. It is well known to anyone skilled in the art that a liquid having a surface tension lower than the critical surface tension of a solid surface, wets completely the solid surface. Thus, if the surface tension of a spin finish is close to the critical surface tension of a hydrophobic fiber, but not below said critical value, spin finish spreading can be improved by increasing the surface free energy of the fiber.

[0021] However, the wetting properties of surfactant solutions can not be estimated by comparing the surface tension values of the wetting liquid to the critical surface tension of the fiber due to adsorption effects of the surfactants and the high polarity of water. Therefore, the contact angle values of spin finishes diluted with water against polypropylene fibers have been measured. The studied spin finishes formed an emulsion with a surface tension varying between 32 mN/m and 38 mN/m. The advancing contact angle has been found to vary between 49° and 57° and the receding contact angle between 20° and 27°, depending on the concentration of the spin finish in water. This indicates incomplete wetting of the fibers by the spin finish emulsions. Thus, increasing the surface free energy values of fibers via corona treatment improves wetting and penetration of spin finishes into the fiber tow during the fiber spinning process. The wettability of the surface of the tow is particularly improved, since the fibers on the surface absorb most of the treatment energy.

[0022] It is believed that the antistatic properties of the fibers are improved, not only by the improved spin finish spreading, but also by the increase of the surface free energy of the fibers during treatment. When the hydrophilicity of the fibers increases, more water adsorbs on the bare fiber surface from humid air. Water forms a conductive layer on the surface, which dissipates static charge. It is believed that both better spin finish spreading and increased hydrophilicity of the fiber surface improve the antistatic properties of the fibers.

[0023] The reduction of the spin finish add-on level is particularly beneficial in the manufacture of hydroentangled nonwovens, where polyolefin staple fibers, preferably polypropylene staple fibers, are used. A spin finish add-on level of 0.05-0.3, typically 0.05-0.2, such as 0.10-0.15 %, by weight of the fibers, was found to give satisfactory surface properties, such as antistaticity, to polypropylene fibers treated according to the present invention. This means that a significant reduction in the impurities dissolving from the fibers in the entanglement water during the hydroentanglement of webs containing polyolefin fibers, can be achieved. As a result, the entanglement water foams less and the circulation degree of water can be increased.

[0024] As a result of corona treatment, adhesion of wetting agents to the surface of treated fibers is also improved. This leads to a better durability of hydrophilicity of spin-finished fibers, when the desorption rate of the wetting agents from the fiber surface into a liquid surrounding the fiber is decreased. Improved durability of hydrophilicity of fibers, resulting from corona treatment, is advantageous when the fibers according to the present invention are used in the manufacture of e.g. thermally bonded nonwoven materials for applications such as coverstock materials in absorbent hygiene products.

Examples

[0025] The following examples illustrate, but do not limit, the basic features of the new invention. The test methods listed below were employed to characterize the fibers and nonwoven fabrics in the examples:

Water contact angles

[0026] The wettability of treated and untreated polypropylene fibers and filaments were determined by means of a Wilhelmy-plate related dynamic contact angle method. Advancing and receding contact angles of a fiber in water were measured with a Cahn DCA-322 dynamic contact angle analyzer by using an immersion speed of 20 µm/s. The immersion depth of a fiber was in the range of 1-2 mm. Fiber perimeter, which is required as a parameter in the method, was determined microscopically.

Determination of spin finish add-on level

[0027] The spin finish add-on level of the fibers was determined by the following procedure: 3 g of the fibers was extracted with 150 ml of ethyl ether. After the extraction, the ethyl ether was evaporated and the residue was dissolved into 10 ml of carbon tetrachloride. The concentration of the spin finish in the solution was analyzed with a Perkin Elmer "Spectrum 1000" FT-IR spectrometer by monitoring the height of the IR absorption peak at 1738.7 cm^{-1} (corresponding to the C=O bond).

Antistatic properties of fibers

[0028] In order to characterize the antistatic properties of staple fibers, the electrical resistance of the fibers was measured with an Eltex Tera-Ohm 6206 resistance meter using a ring electrode according to the DIN 54345 T1 standard. The fibers were carded into a web, and the resistance of a 1 g sample of the web was measured in a constant 60% RH (relative humidity) and 25 °C temperature after 16 h conditioning. The electrical resistance represents the ability of fibers to dissipate static charge. Thus the higher the resistance of fibers is, the poorer are the antistatic properties. Typically, a resistance of lower than 10^{10} Ω is required with staple fibers in nonwoven production. The antistatic properties

were evaluated according to the following scale based on the measured values of the electrical resistance: R/ Ω: R > 10^{13} = NIL, 10^{11} < R<10^{12}= POOR, 10^{10}<R<10^{11} : MODE-RATE, R<10^{10} = GOOD.

[0029] The antistatic properties were further characterized by measuring the static charge of a web with an Eltex EM-01 Fieldmeter during carding. 25 g of staple fibers were carded in 60% RH, 25°C and the electric field was measured by placing the field sensor above the web at a distance of 6.0 cm.

Water absorbency time of fibers

[0030] Fibers were carded into a web, and the sinking time of the web placed on a water container was determined according to the EDANA Recommended Test Method ERT 10.2-96 1. "Liquid Absorbency Time"

Example 1

[0031] A polypropylene fiber tow containing 30500 filaments was extruded in the compact spinning line shown in Figure 1. The titer of the fibers, which did not contain spin finishes, was 5.0 dtex. The fiber tow was corona treated with a Sherman treaters PBS350 electrode unit (shown as (15) in Fig. 1) connected to a Sherman treaters GX20 generator. The treatment energy varied between 0.3 - 1.6 J/cm^2.

[0032] As a comparative sample, an identical fiber tow without corona treatment was produced.

[0033] The effect of the corona treatment was studied by measuring the water contact angle on the surface of ten individual fiber filaments taken randomly from the treated and untreated fiber tows. The average contact angle values are listed in Table 1. Table 1 indicates that corona treatment of a polypropylene fiber tow increases the surface free energy of the filaments in the tow. This can be seen as a decrease of the water contact angle values of the filaments as a function of corona treatment energy.

Table 1

Water contact angles of unfinished polypropylene filaments			
SAMPLE	Corona energy, J/cm^2	Contact angle Advancing, °	Contact angle Receding, °
1.0	0	101	96
1.1	0.3	89	74
1.2	0.8	93	83
1.3	1.6	85	69

Example 2

[0034] In this example, 3.5 dtex polypropylene staple fibers were produced with the compact spinning line shown in Figure 1. Referring to Figure 1, the corona treatment (15) was performed after the first spin-finishing (14) as described in Example 1. The second spin finishing (21) was done before the crimper (22). The corona treatment energy was 0.6 J/cm^2 during the production. Four sets of corona treated staple fibers, having spin finish add-on level between 0.11 % and 0.20% by weight of the fibers, were produced. The spin finish used was a conventional finish formulation for PP fibers, comprising a mixture of phosphoric acid ester antistatic agent with ethoxylated fatty acids and fatty acid esters as lubricants. Such a finish formulation is *e.g.* Silastol GF602 available from Schill & Seilacher GmbH & Co (Boeblingen, Germany). As comparative samples, corona-untreated fibers were produced with the same spin finish add-on levels.

[0035] The contact angle of the fiber tow after the corona treatment was measured as an average of fifty individual filaments as described in Example 1. Corona treated filaments were found to have an advancing contact angle value of 93° and a receding contact angle value of 79°. The contact angle values for the untreated filaments were 101° and 91°, respectively. The antistatic properties of the fibers were characterized by measuring the resistance of the fibers. The hydrophilicity of the fibers was evaluated by the water absorbency time test method. Table 2 lists the measured properties of the fibers with different spin finish add-on levels.

Table 2

SAMPLE	Spin finish add-on, wt%	Corona energy, J/cm^2	Resistance $10^9\ \Omega$	Antistatic properties	Water absorbency time, s
2.1	0.11	0	> 1000	NIL	>600
2.2	0.13	0	100	POOR	>600
2.3	0.18	0	10	MODE-RATE	3.4
2.4	0.20	0	6.4	GOOD	2.9
2.5	0.11	0.8	100	POOR	>600
2.6	0.13	0.8	8.3	GOOD	3.3
2.7	0.18	0.8	2.2	GOOD	2.3
2.8	0.20	0.8	1.5	GOOD	2.3

[0036] As can be seen from Table 2, untreated fibres are hydrophobic and have poor antistatic properties with a lower spin finish add-on level than 0.18 wt%. On the other hand, corona treated fibres are hydrophilic and have good antistatic properties already with a spin finish add-on level of 0.13 wt%. The results in Table 2 clearly indicate that when the fibre tow is corona-treated, fibres with sufficient antistatic and hydrophilic properties can be produced with significantly reduced add-on levels of spin finish

Example 3

[0037] In this example, 2.2 dtex polypropylene staple fibres were produced with the compact spinning line shown in Figure 1 as described in Example 2. The corona treatment energy was 0.6 J/cm^2 during the production. Two sets of corona treated staple fibres, having spin finish add-on level between 0.09 % and 0.12% by weight of the fibres, were produced. As comparative samples, untreated fibres were produced with the same spin finish add-on levels.

[0038] The contact angle of the fibre tow after the corona treatment was measured as an average of forty individual filaments as described in Example 1. Corona treated filaments were found to have an advancing contact angle value of 92° and a receding contact angle value of 83°. The contact angle values for untreated filaments were 97° and 91°, respectively. Antistatic and hydrophilic properties of the fibres were characterized as described in Example 2. In addition, the static charge build-up during carding was measured. The results of the tests are listed in Table 3

Table 3

SAMPLE	Spin finish add-on, wt%	Corona energy, J/cm^2	Resistance $10^9\ \Omega$	Antistatic properties	Static charge build-up. -kV/m	Water absorbency time, s
3.1	0.09	0	> 1000	NIL	>50	>600
3.2	0.12	0	50	MODE-RATE	16	>600
3.3	0.09	0.6	260	POOR	20	>600
3.4	0.12	0.6	8.1	GOOD	9	>600

[0039] The results shown in Table 3 indicate that even when the spin finish add-on level is low enough not to render the fibers hydrophilic (sinking time values >600 s), the corona treated fibers have considerably better antistatic properties and about 50% less static charge build-up during carding than the untreated fibers. It can be concluded that cardable polypropylene fibers with good antistatic properties can be produced with corona treatment during melt-spinning, when the spin finish add on level is as low as 0.12 wt%.

Claims

1. A method for producing hydrophobic polymer fiber filaments with increased surface free energy, the method comprising the following steps

- forming a melt from a hydrophobic polymer,
- melt-spinning the polymer to form filaments,
- applying a spin finish to the filaments, and
the method being **characterized** in that it includes a step of
- subjecting the filaments to at least one surface treatment step to increase the surface free energy thereof.

2. The method according to claim 1, **characterized** in that the surface treatment step comprises a corona discharge, plasma or flame treatment.

3. The method according to claim 1 or 2, **characterized** in that the polymer is a polyolefin, preferably polypropylene.

4. The method according to claim 1, 2 or 3, **characterized** in that a spin finish is applied to the filament after a surface treatment step.

5. The method according to any one of the preceding claims, **characterized** in that a surface treatment step is carried out after the formation of filaments after melt-spinning, in the vicinity thereof.

6. The method according to any one of the preceding claims, **characterized** in that it includes a step of drawing the filament.

7. The method according to claim 6, **characterized** in that when a draw ratio of more than 1.5 is used in the drawing step, the filaments are subjected to a surface treatment step after the drawing step.

8. The method according to any one of the preceding claims, **characterized** in that the add-on level of spin finish is 0.05-0.3, preferably 0.05-0.2 % by weight, calculated from the weight of the filament.

9. The method according to any one of the claims 2 to 8, **characterized** in that a corona discharge energy of 0.3 - 1.6 J/cm^2 is used.

10. The method according to any one of the preceding claims, **characterized** in that it contains the additional step of forming a nonwoven from the filaments or from fibers made therefrom, and hydroentangling the nonwoven.

11. The method according to any one of the preceding claims, **characterized** in that it includes the steps of

    - crimping and cuffing the filaments into staple fibers,
    - carding the staple fibers and forming a nonwoven web therefrom, and
    - hydroentangling the nonwoven.

12. A production line for the production of hydrophobic polymer fiber filaments, preferably polyolefin, such as polypropylene fiber filaments, comprising

    - means (11,12) for producing polymer filaments from a polymer melt,
    - means (14,16,21) for applying a spin finish to the filaments, and optionally means for crimping (23) and cutting (24) the filaments into staple fibers, **characterized** in that it comprises
    - means (15,20) for subjecting the filaments to a surface treatment step for increasing the surface free energy thereof.

13. The production line according to claim 12, **characterized** in that the surface treatment means comprise a corona discharge or plasma treatment unit.

14. The production line according to claim 12 or 13 , **characterized** in that includes means for drawing the filaments.

15. The production line according to claim 14, **characterized** in that surface treatment means are provided after the drawing means, in the direction of filament production.

16. Use of a filament produced in a method according to any one of the claims 1 - 9, or in a production line according to any one of the claims 12 - 15, or of a fiber made from such a filament, for manufacturing a nonwoven using a hydroentanglement method.

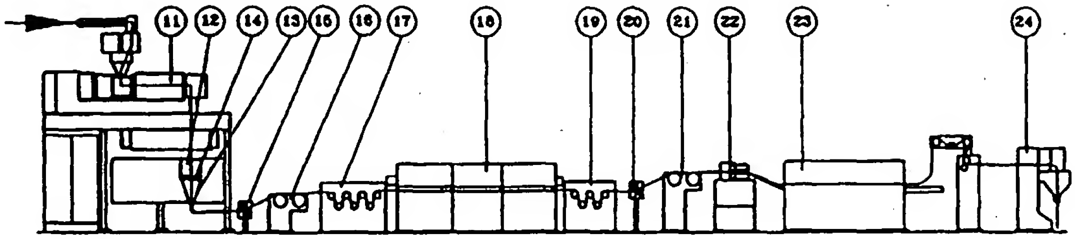

FIG. 1.

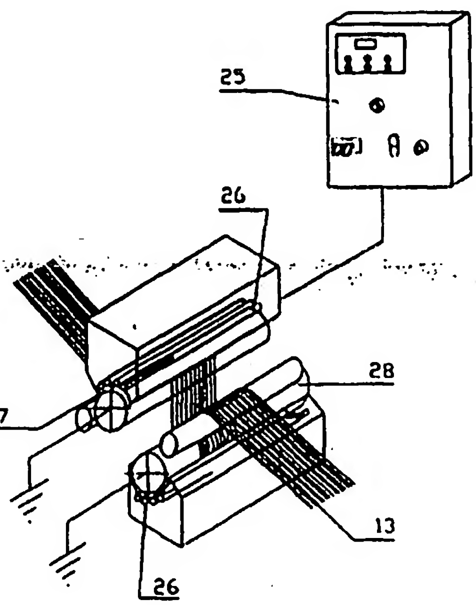

FIG. 2.

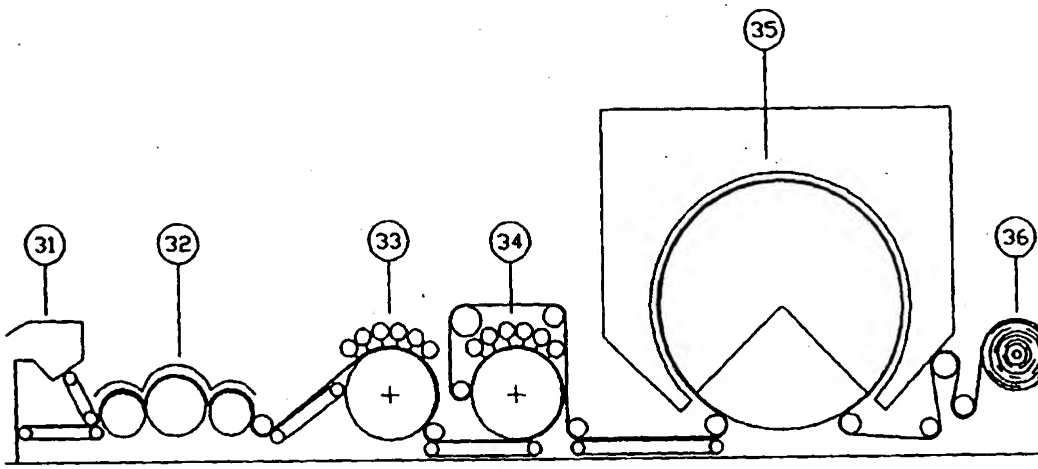

FIG. 3.-

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EUROPEAN SEARCH REPORT

Application Number
EP 00 66 0006

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D01D
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D04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 April 2000	Tarrida Torrell, J

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